STRIVE

PARTNERS

BENTLEY

Northwest automotive Alliance

VIRTUAL ENGINEERING CENTRE

OPTIS

DNA agile

Department for Business Innovation & Skills

STRIVE has been awarded funding from the Advanced Manufacturing Supply Chain Initiative (AMSCI). AMSCI is funded by the Department for Business, Innovation & Skills (BIS) and is managed by Finance Birmingham on behalf of BIS.

Experiencing virtual manufacturing:

Collaboration in Product and Process Development

Project overview: Dr Ferdinando Milella, Virtual Engineering Centre
Technical perspective: Andy Reilly, Optis Northern Europe
OEM perspective: Senga Shufflebotham, Bentley Motors

SAE 2015 Augmented and Virtual Reality (AR/VR) Technologies Symposium

Topics

- Project overview and robust assessment framework
- OEM challenge
- SME solution
- Impact

STRIVE

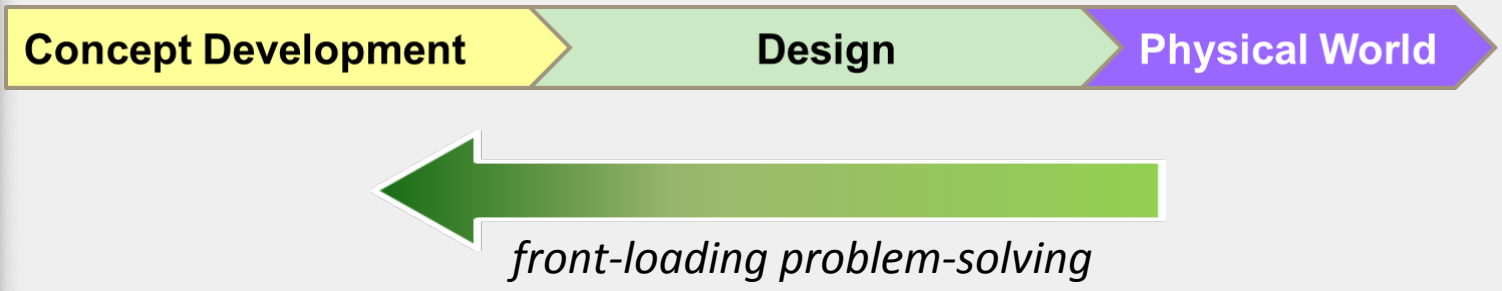
The project

PROJECT

VIRTUAL ENGINEERING CENTRE

Dr Ferdinando Milella
Virtual Engineering Centre (VEC)

STRIVE: buying time and saving money



Ability to achieve targets, reduce cost and improve time to market

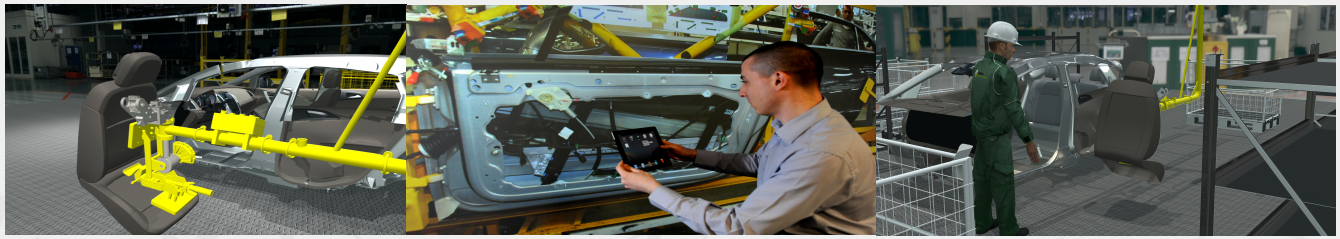
RATIONALE

VIRTUAL ENGINEERING CENTRE

STRIVE

New digital supply chain: Why?

- Manufacturing is changing and many physical processes are being replaced by digital processes.
- Provide a route for SME's to exploit innovative software tools and accelerate impact.
- Developing a seamless and integrated solution, driven by OEM needs.



STRIVE

Creating a new digital supply chain

Aims of STRIVE:

- Transforming the New Product Development process in order to fully exploits the benefits of high fidelity model analysis and immersive virtual prototypes

- To create a new “digital” supply chain to support UK manufacturing which is increasingly having to adopt virtual technologies to remain globally competitive

- Support the development of ‘digitally enabled engineers’ for faster adoption of innovative technologies.

AIMS

VIRTUAL ENGINEERING CENTRE

STRIVE

BENTLEY

automotive Alliance

VIRTUAL ENGINEERING CENTRE

OPTIS

Icona Solutions

DNA agile

PARTNERS

VIRTUAL ENGINEERING CENTRE

A collaborative R&D project

- **Bentley Motors** | OEM and R&D test bed
- **Northwest Automotive Alliance (NAA)** | Contract lead partner
- **Virtual Engineering Centre** | University of Liverpool, technical lead partner
- **OPTIS** | SME delivery partner, physics based simulation software
- **Icona Solutions (*OPTIS Pristine*)** | SME delivery partner, perceived quality specialist software
- **DNA Agile (*Valuechain.com*)**| SME delivery partner, cloud-based data capture and workflow systems

STRIVE

Department for Business Innovation & Skills

finance birmingham

FUNDING

VIRTUAL ENGINEERING CENTRE

Funding and support

Advanced Manufacturing Supply Chain Initiative (AMSCI)

- **STRIVE is a three year R&D project - now in final year**
- The STRIVE project was awarded funding from the Advanced Manufacturing Supply Chain Initiative (AMSCI) – a Department for Business Innovation and Skills (BIS) initiative to support the development of UK Manufacturing Supply Chains
- The AMSCI programme is managed by Finance Birmingham.

STRIVE

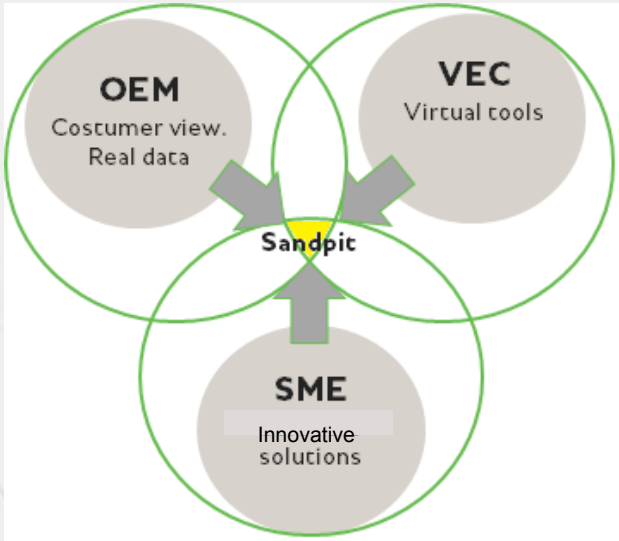
“VEC sandpit”

Strategic partners & Creating New Supply Chains

Our Research Process:

- Innovation Sand Pit
- Consortium working
- Business Driven

VIRTUAL ENGINEERING CENTRE



APPROACH

VIRTUAL ENGINEERING CENTRE

STRIVE

Robust development

Underpinned by academic expertise at the **University of Liverpool**:

VEC Digital Design and Manufacturing (School of Engineering)
Design and realisation of Virtual Immersive Environments, motion and object tracking, development of VR interactive modules, tactile feedback software and hardware development, VR/AR system integration, etc.

School of Psychology
(Multi-)sensory perception and cognition, multisensory integration, VR presence and immersion analysis, task performance evaluation, behavioural analysis, etc.

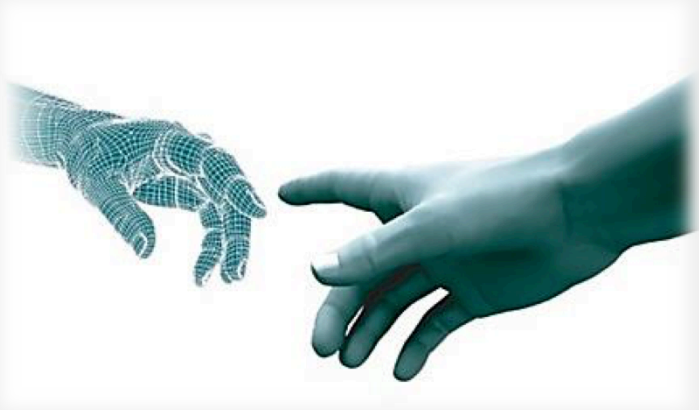
R&D

VIRTUAL ENGINEERING CENTRE

STRIVE

Immersion and presence

Fundamental concepts to understand subjects' physical and psychological experiences in virtual environments.



Presence – subjective experience of being in one place or environment, even when one is physically situated in another (Witmer and Singer, 1998)

Immersion – refers to objective level of sensory fidelity that a VR system provides (Slater, 2003)

Two approaches:

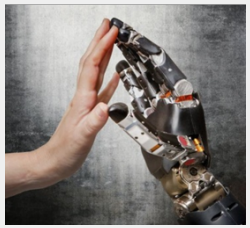
- **Subjective** – conscious introspective judgment regarding their experience (questionnaires)
- **Objective –** physiological or behavioral responses (performance)

R&D

VIRTUAL ENGINEERING CENTRE

STRIVE

Immersive Virtual Reality allow us to interact and perceive the environment through different modalities (**visual**, **audio** and **tactile**) to improve subject's presence and quality of experience in real time



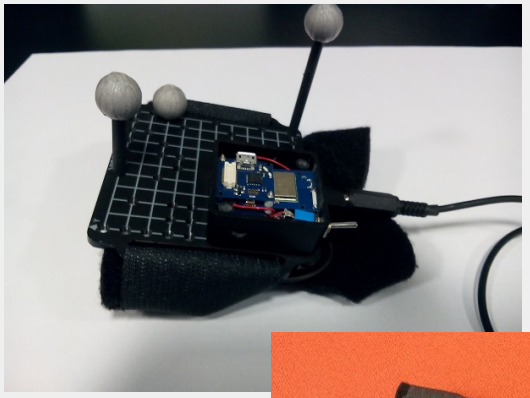
Software plug-ins and modules have been developed and tested by the VEC to implement **multi-sensory modality** (combining visual, audio and tactile cues) in STRIVE tools to enhance understanding of issues and problem-solving capabilities.

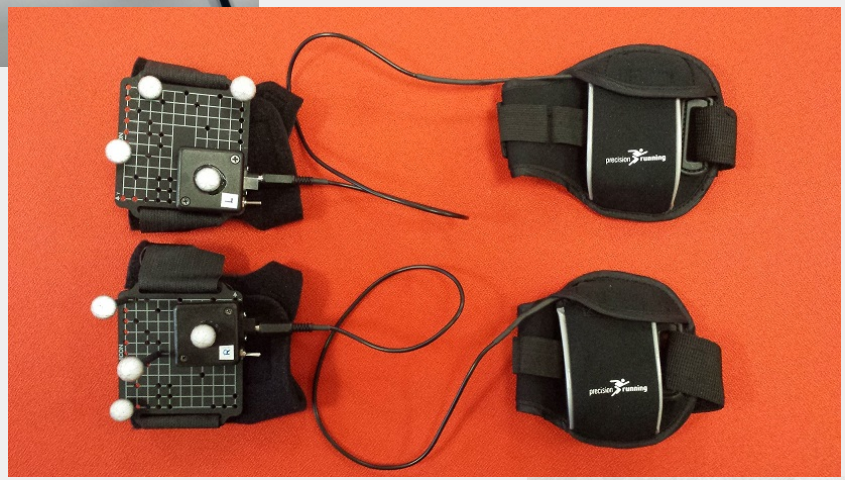
R&D

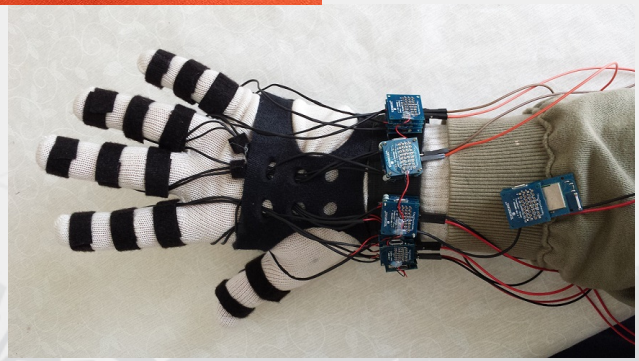
VIRTUAL ENGINEERING CENTRE

STRIVE

Haptic (Tactile) Devices







R&D

VIRTUAL ENGINEERING CENTRE

STRIVE

Cues in virtual reality

In collaboration with:

UNIVERSITY OF LIVERPOOL | SCHOOL OF PSYCHOLOGY

- Behavioral study – to evaluate human performance in VR environment
- Perception study, using factorial design, ANOVA - all possible combination of conditions

VIRTUAL REALITY ⇒ **high realism, high fidelity**

Key questions:

- Do we need all cues to be perfect?
- Do we need all the information to be accurately rendered?
- What about giving additional cues?

R&D

VIRTUAL ENGINEERING CENTRE

STRIVE

Underpinning research

Main aim - investigate which sensory feedback contribute most to task performance and the sense of presence in virtual reality environment.

Hypotheses:

1. Faster overall completion times and higher sense of presence when multimodal feedback is presented.

2. Slower overall completion time and increased reports of discomfort during modulation of the VR environment.

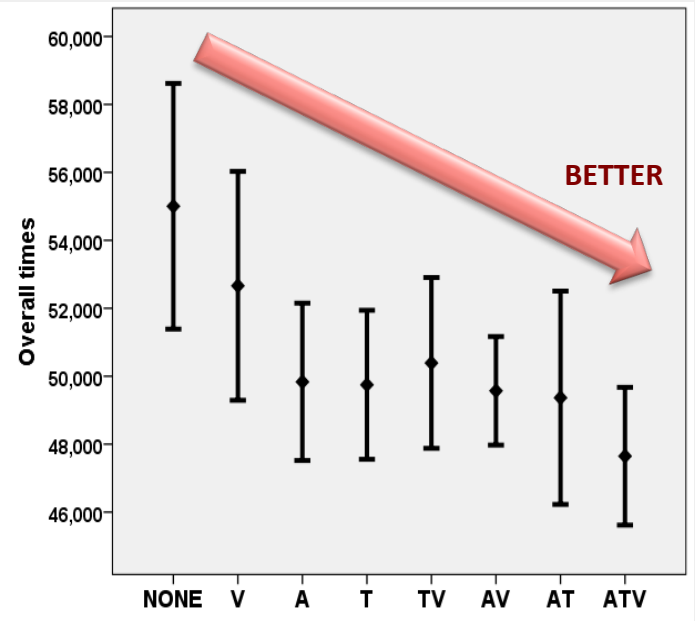
Methods

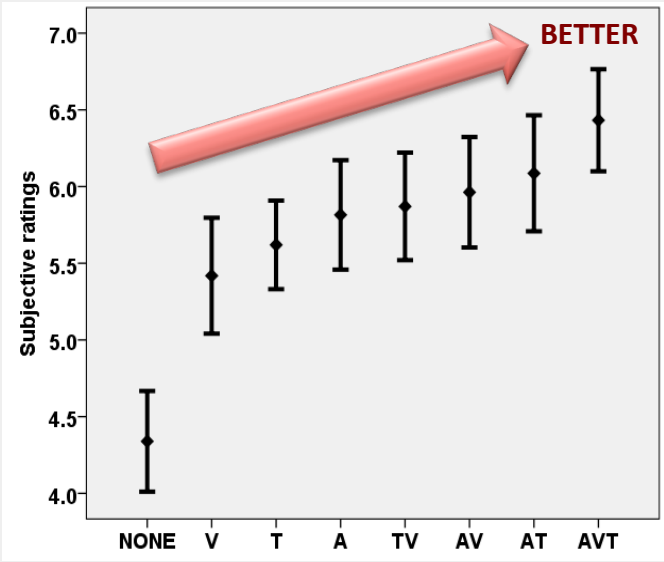
* 16 participants,
* 3D power wall at Virtual Engineering Centre, Daresbury
* Objective measures - task performance
* Subjective measures - Immersive tendencies questionnaire (ITQ)(Witmer and Singer, 1988), Presence questionnaire (PQ)(Witmer and Singer,1988), Simulation Sickness questionnaire (SSQ) (Kennedy et al, 1993)

R&D

VIRTUAL ENGINEERING CENTRE

Results: objective vs subjective data





Participants performed the best and reported an enhanced sense of presence when multimodal feedback was present (AVT) followed by bimodal feedback (AV, AT,TV) and then by unimodal feedback (A, T, V).

R&D

VIRTUAL ENGINEERING CENTRE

STRIVE

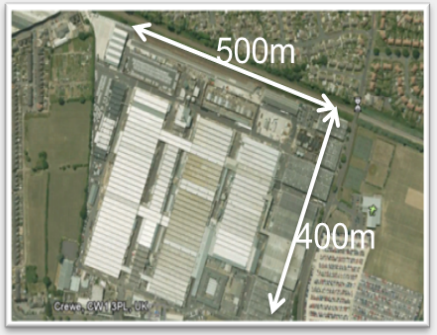
The OEM Challenge

Senga Shufflebotham
Bentley Motors

OEM
PERSPECTIVE

STRIVE

Introduction to Bentley factory, Crewe



- Over 4,000 employees in Crewe, Cheshire

- All functions integrated on one site

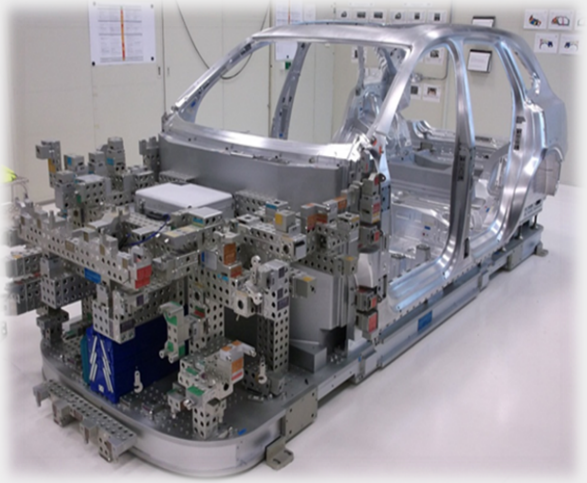
- **Manufacture <u>all</u> main components, Wood, Leather, Engine , Seats etc…**

BENTLEY FACTORY

STRIVE

Why Bentley joined STRIVE

Technical Challenges & Purpose Of the Project



- Current high use of Physical Properties
- Bentley "Manufacturing "not exploiting opportunities of virtual technologies.
- Low levels of investment available, economies of scale.
- The use of different data sets across various functions causes conflicts (Concept, Eng, Man)
- Government Regional Growth Funding Available

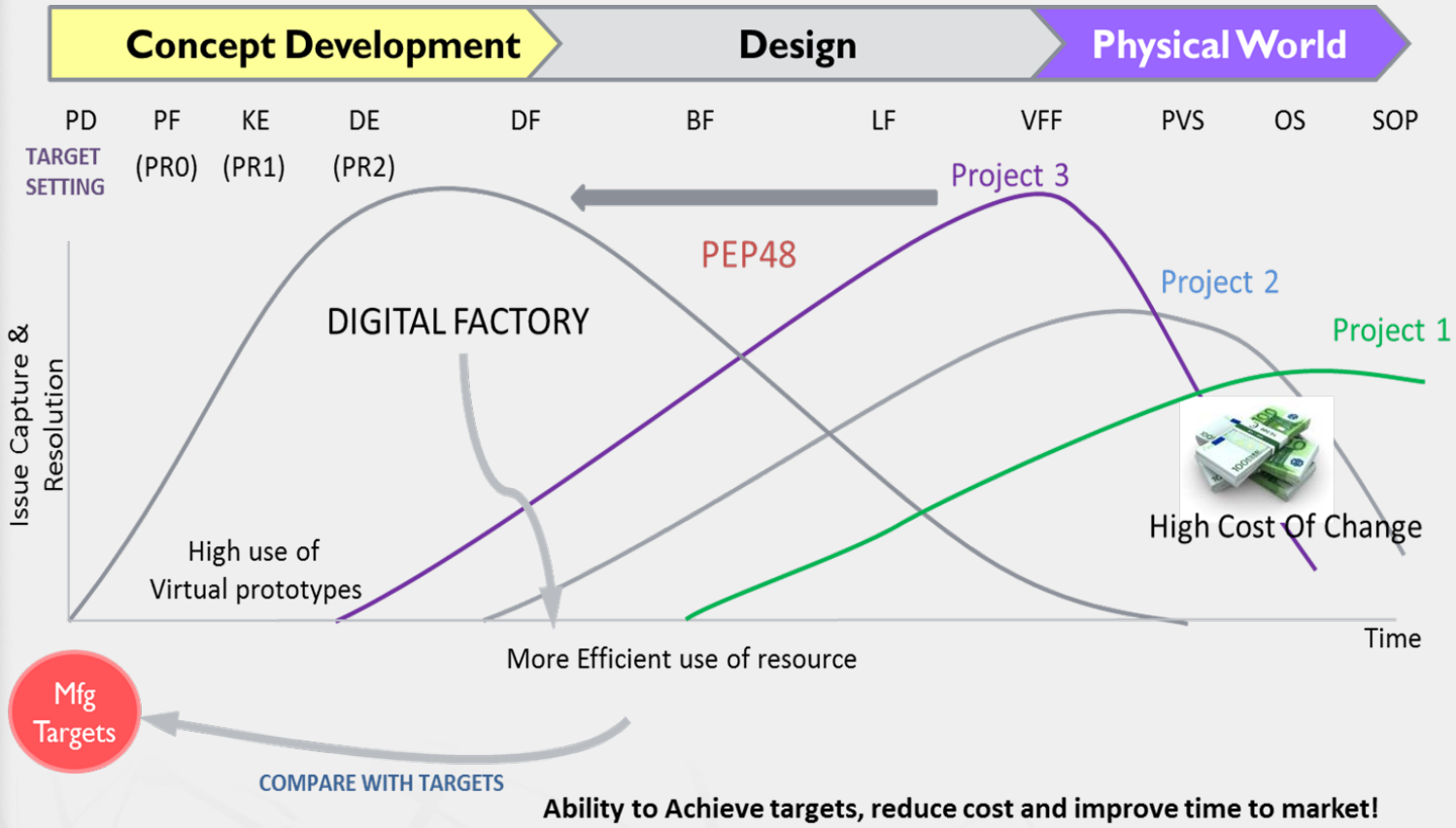
TECHNICAL CHALLENGES

Bentley aim:

- To reduce project investment on physical models/ properties
- To have one common data set used cross business
- To instigate Dynamic Immersive Cross Functional Review
- Increase effectiveness of visualising manufacturing feasibility
- **Identify and resolve problems earlier in the project cycle**

STRIVE

Bentley key driving factors



Ability to Achieve targets, reduce cost and improve time to market!

KEY FACTORS

STRIVE

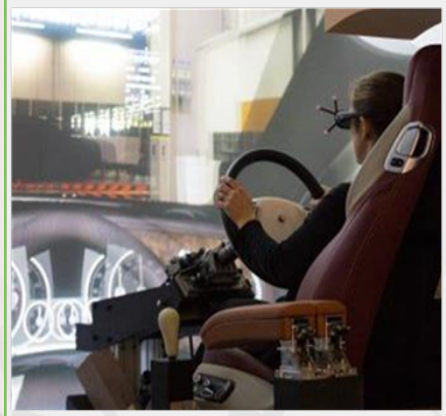
Bentley requirements

BENTLEY REQUIREMENTS

1

Visualisation

Allows us to view vehicles in an immersive environment that looks and feels real, visualising manufacturing issues on surface of the car.



2

Immersive Manufacture and Assembly

Allows us to assess the vehicle build before parts are available, validate processes & drive design changes to parts and use virtual reality as a training aid.

3

Real-time Issue Capture and Resolution

Allows us to capture and resolve issues real time, reducing inefficiency in capturing issues.

Bentley work stream 1: visualisation

- Cross functional reviews
- Immersive visualisation of gap and rad targets
- Circa 17 surface changes already instigated on new projects

WORK STREAM 1
VISUALISATION

Bentley work stream 2: immersive manufacture

- Demonstrations ran to gain input from Bentley employees in tool development
- Used for identification/ resolution of:
    - Part load issues
    - Ergonomic assessments
    - Tool access
- Already stopped 2 no build issues on new projects

WORK STREAM 2 IMMERSIVE MANUFACTURE

STRIVE

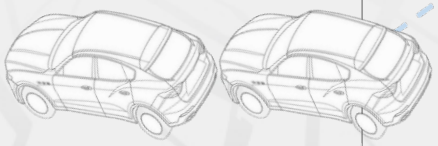
Bentley work stream 3: issue capture

Live Issue Capture

Virtual Reviews

Immersive Manufacture

Physical Builds



Bentley iQapture Server

Issue Tracking and Reporting

- Advanced Issue Filtering
- Ampleblatt Generation
- Report Generation
- KPI Monitoring
- Concurrent Working
- Issue Closure

WORK STREAM 3 ISSUE CAPTURE

STRIVE

Meeting OEM requirements through SME Innovations

Andy Reilly, Country Manager - Optis Northern Europe

SME SOLUTION

OPTIS

OPTIS

Icona

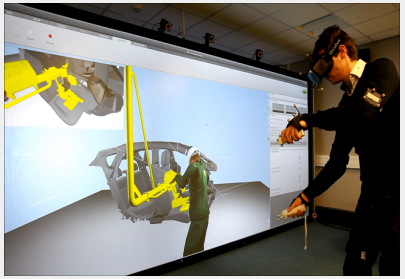
DNA agile

STRIVE

Integration of technologies

- Perceived quality assessment

- Virtual manufacture and assembly



- Real-time issue capture and resolution

TECHNOLOGY INTEGRATION

Perceived quality assessment

Perceived quality assessment before STRIVE

- High use of physical properties.
- Bentley manufacturing not exploiting opportunities of virtual technologies sufficiently

STRIVE

Perceived quality assessment with STRIVE

Interior audit

USING STRIVE

STRIVE

Perceived quality assessment with STR

Exterior audit

USING STRIVE

STRIVE

Immersive virtual manufacture and assembly

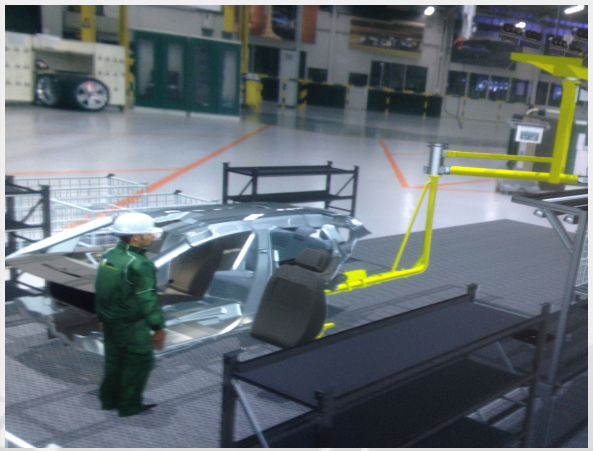
STRIVE

Why a virtual approach?

No need to wait for the first physical parts to:

- Check for assembly by operator
- Visualise product and environment
- Review the whole assembly
- Capture and resolve issues
- Train operators to assemble parts

Manikin in the scene for improved ergonomic assessment



STRIVE

Culture and process change

Seat assembly at Bentley:

PROCESS CHANGE

Culture and process change

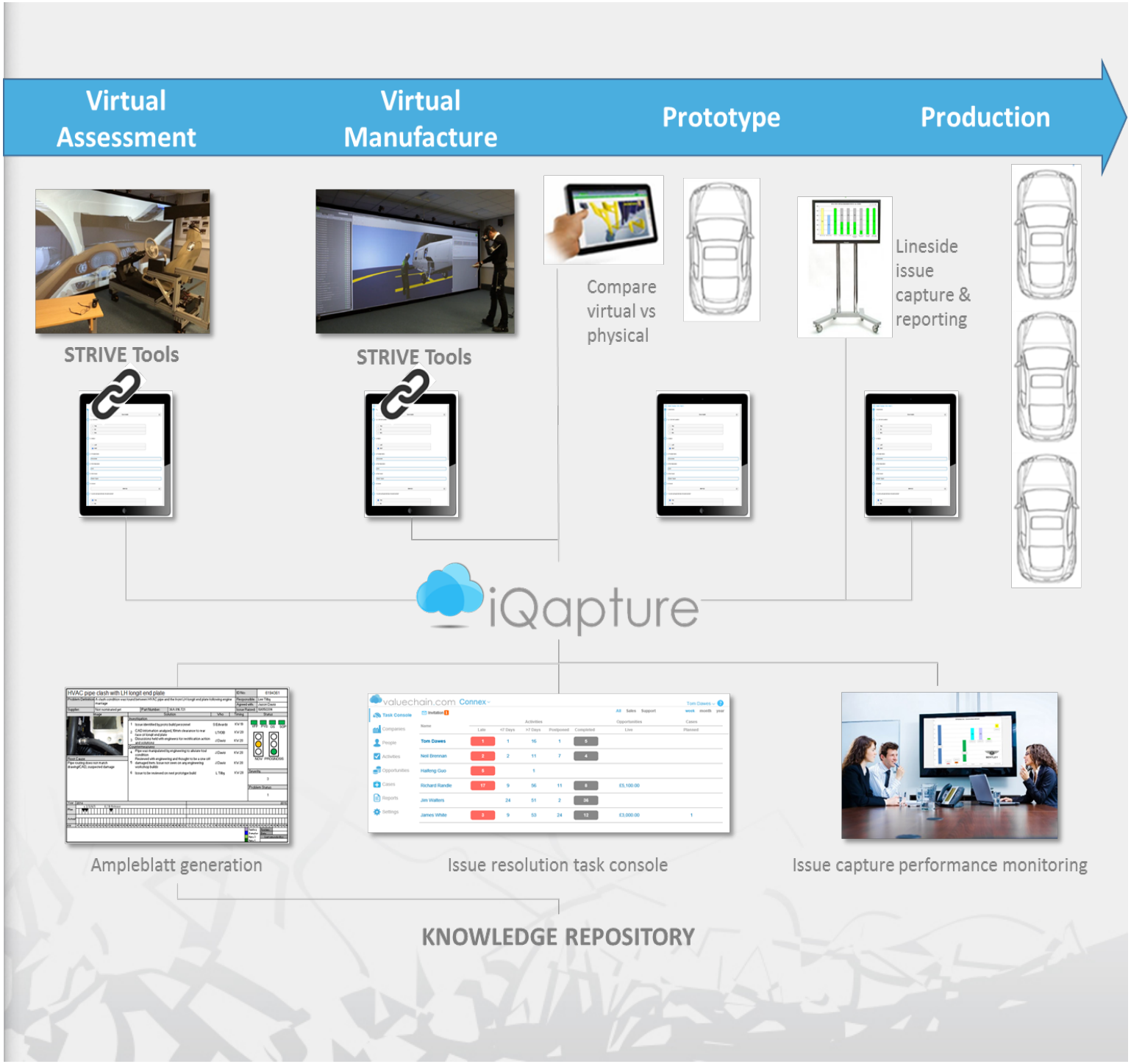
Seat assembly - STRIVE tools:

PROCESS DEVELOPMENT

Digital issue capture and resolution

STRIVE

PROCESS AND TOOLSET INTEGRATION



STRIVE

Benefits of real-time issue capture

- Reduces time and costs by streamlining feedback and reporting process
- Proactive issue resolution tracked through integrated task consoles
- Integrated knowledge repository from virtual visualisation through to physical production

EARLIER ISSUE CAPTURE

STRIVE

BENTLEY

automotive Alliance

VIRTUAL ENGINEERING CENTRE

OPTIS

Icona Solutions

DNA agile

Impact and future

STRIVE

BENTLEY

automotive Alliance

VIRTUAL ENGINEERING CENTRE

OPTIS

Icona Solutions

DNA agile

Benefits of collaboration

- Fully integrated solution
- 40 Bentley engineers involved in trialling new digital tools
- Co-development of tools based on feedback from manufacturing engineers
- Impact - Bentley already using STRIVE tool set in vehicle development at concept development stage (PR1 and PR2)
- Creating high growth in SMEs
- Safeguarding high value engineering jobs

STRIVE

BENTLEY

automotive Alliance

VIRTUAL ENGINEERING CENTRE

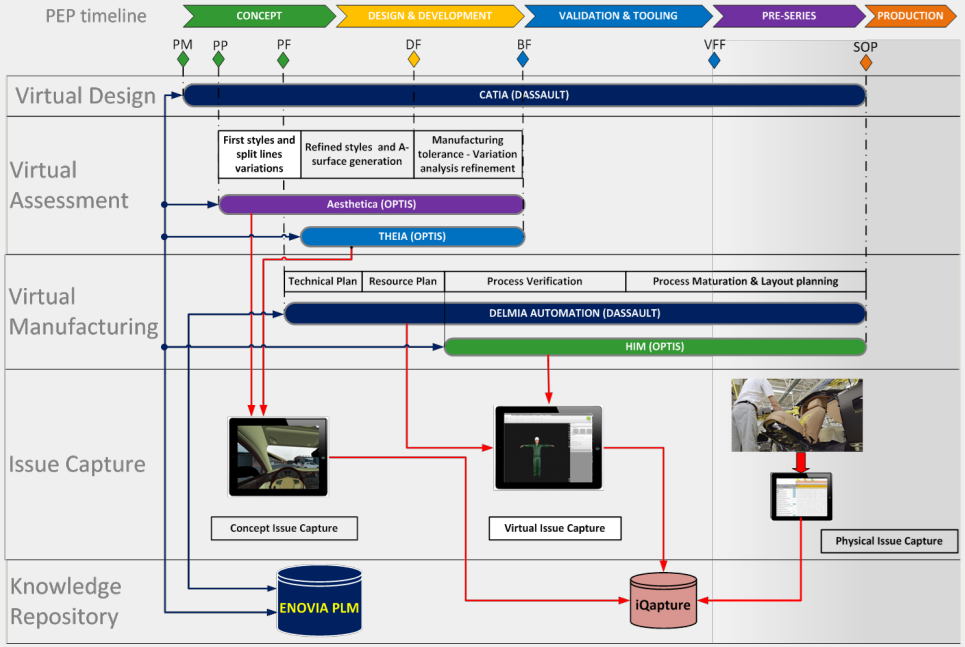
OPTIS

Icona Solutions

DNA agile

Impact

- Integrated solution
  - desktop
  - immersive
  - shop floor
- Based on reality
  - physics based
  - real time



STRIVE

BENTLEY

automotive Alliance

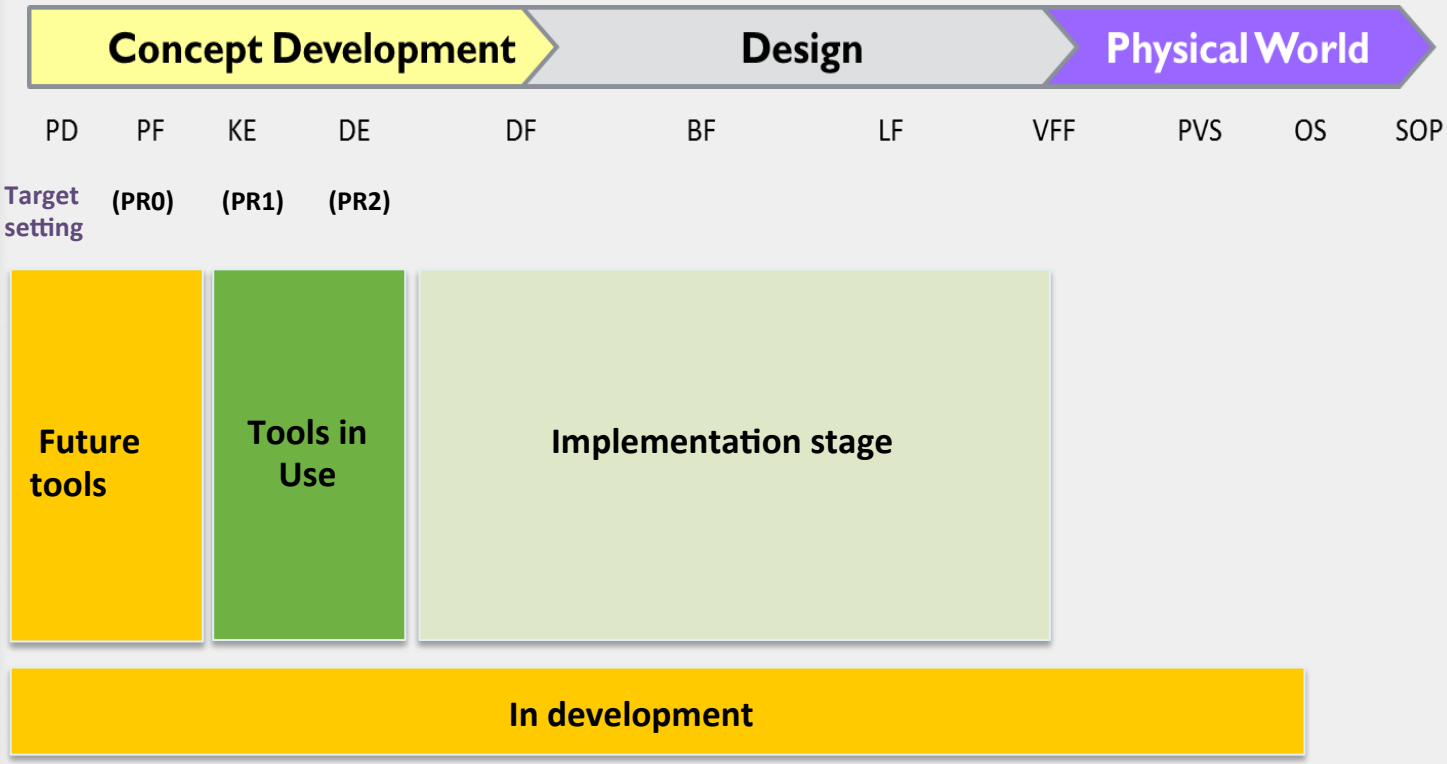
VIRTUAL ENGINEERING CENTRE

OPTIS

Icona Solutions

DNA agile

Benefits of collaboration



STRIVE

Bentley- implementation and future

BENTLEY
FUTURE

STRIVE

PARTNERS

BENTLEY

Northwest automotive Alliance

VIRTUAL ENGINEERING CENTRE

OPTIS

DNA agile

Department for Business Innovation & Skills

STRIVE has been awarded funding from the Advanced Manufacturing Supply Chain Initiative (AMSCI). AMSCI is funded by the Department for Business, Innovation & Skills (BIS) and is managed by Finance Birmingham on behalf of BIS.

STRIVE

Simulation Tools for Rapid Innovation in Vehicle Engineering

Thank you for listening